PRINCIPLE AND PRACTICE.

BY R. F. HARTFORD.

Every structure, whether large or small, should be the criterion by which we estimate the skill and ability of the builder. No engineer, while regarding the best interests of himself and his profession, can afford, at any time, to do other than his best work; and he should honor both.

The charlatan can produce only insecure or extravagant structures, excepting when guided by chance. The engineer can, therefore, and should, make the greatest contrast between his and all pretenders' labor. Let the builder, be who he may, if any structure be poorly designed and unskillfully done, it in no wise better than the engineer's work, and the engineer is deserving of no higher recognition.

It is not in elaborateness of detail nor in immensity of structure that true engineering skill is shown, but it is in the placing of the best available material in the best possible position. The experienced eye can detect this skill in the designing and construction of a road culvert as fully as in a Douro viaduct. Not what we do, but how we do it, makes the vast difference between the true and the false.

I am led to these remarks by having seen the erection of a reservoir wall, under the direction of an engineer who, I know, can do good work, but the use of a highly permeable material where a better one was procurable, and rubble masonry where well bonded ashlar should be, did not speak much of skill. There is far more of this "well enough" work than there should be. It is seen in our mines, in our bridges, in our railroads, in the details of municipal work everywhere.

There are many works in our land to which we may look with just pride; and some of them are not the worst imposing, but there are also many deserving only of the most adverse criticism and condemnation. No small number of these last are the productions of skilled engineers, into whose labors too much of "sham" has been permitted to enter. The truly emulous of our profession will fully examine and commend every detail of their work before permitting it to enter their work construction.

The careless and irresponsible only will accept the "sham;" and these people, be their power ever so great, deserve no other placing than with quacks and charlatans—they are true associates.

Every engineering structure, be its office of major or minor importance, should fill its designed purpose as completely as does that grand monument of Herrara's skill, the reservoir of Alicante. If permanency be the thing sought, it should be the thing secured. If economy must govern (and it should) we must not mistake the word for scantiness.

Many failures result in minor structures, to which we give little heed, regarding them of no importance, but they should reflect as much upon the designer and builder as a greater failure would. The false ought never to be measured small; the engineer should see no intermediate between the good and the bad.

We should aim to produce better work among our engineers, not with the careful few, but with the careless many. We should always denounce imperfect design, loose calculation, sham erection and careless supervision shown by any one, as we denounce any quackery. This must be done that charlatanism may move alone, within a well-marked limit.

And this leads us to the consideration of engineering details, for it is in these that the true engineer excels.

Every engineer in practice is often met with problems requiring prompt and cool action. They may come from the sudden inrush of water or quicksand, the sharp snap of a bridge tie, the unexpected subsidence of a well or any of the myriad of accidents which so often confront the engineer. There must necessity be much of the "rough and ready" in the decision; but if the engineer be thoroughly conversant with the properties of matter; if he comprehends the forces in different parts of structures and be able to determine their relations, and more, if his mind be stored with a

knowledge of what others have done, his decision will be prompt, the remedy will be at hand, there will be much of the ready and little of the rough. One man in a century will originate; all the rest must have recourse to what others have done. The engineer who shall combat successfully his ever besetting obstacles must be a reading man. From every source he must be gathering matter for future use. There is no profession requiring a greater diversity of knowledge or more intense study than does that of the engineer. No idler can succeed in this work; the brain and hand must be ever alert.

If a work is worth doing at all, it is worth our deepest thought, our closest scrutiny, our best application. No structure, however insignificant, should be begun, the concept of which has not been predeveloped to the minutest detail. If this forethought has been taken, accidents will be reduced to a minimum. All possible ones will have been anticipated so far as the human mind can predetermine.

I was once shown a copy of specifications intended for guidance in the construction of a dwelling. It was written on one-half sheet of "legal cap," and was the work of a well known firm of architects. But even from reputable engineers such papers come.

Specifications can not be too fully and too clearly written. There are few contractors who can be entrusted to carry out all the details of a work without specifications, even if they were honestly desirous of doing so. The nature and extent of such papers will, of course, depend on the nature of the projected work, but they should make clear everything which the drawings do not.

A great advantage accrues to a contractor from well written specifications, but a greater goes to the engineer. The contractor is not clouded by any obscure passages which invite "strain" bids, fraudulent proposals and sham work, and is enabled to make with confidence an honest offer. The benefit to the engineer comes from the conception of the work to be done, for no man can prepare a good specification without a clear conception of the *whole* work. I have always felt that improper specifications are positive evidence that the engineer, from whom they come, has been viewing a shadow; and dishonest contractors cluster closest about loose descriptions and uncertain details.